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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 388.

Experiment Station Work, LVI.

Compiled from the Publications of the Agricultural Experiment Stations.

INCOMPATIBLES IN FERTILIZER MIXTURES.
PRINCIPLES OF DRY FARMING.
METHODS OF SEEDING OATS.
ROLLING *v.* HARROWING WINTER WHEAT.
DESTRUCTION OF EELWORMS IN SOIL
PRUNING.
BEAN ANTHRACNOSE OR POD SPOT.
ANIMAL FEEDS FOR FARM STOCK.
FEEDING THE PIG.
JELLY AND JELLY MAKING.

JANUARY, 1910.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

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EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

CONTENTS OF NO. LVI.

ILLUSTRATIONS.

EXPERIMENT STATION WORK.[a]

INCOMPATIBLES IN FERTILIZER MIXTURES.

In a previous bulletin of this series[b] the danger of indiscriminate mixing of fertilizing materials was briefly explained, and a diagram was given which indicated what combinations may be safely made of some of the more common fertilizing materials. Figure 1 is a somewhat more elaborate diagram of the same kind, including, in addition

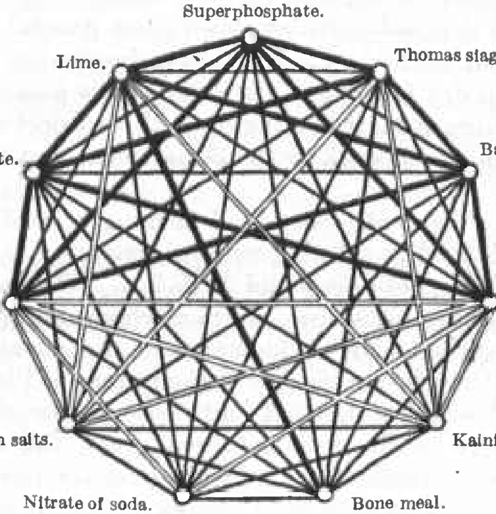

FIG. 1.—Diagram indicating what fertilizer materials may and may not be safely mixed. The dark lines unite materials which should never be mixed, the double lines those which should be applied immediately after mixing, and the single lines those which may be mixed at any time.

to the materials shown in the simpler diagram, bone meal and the new nitrogenous fertilizers, lime nitrogen (calcium cyanamid) and Norwegian nitrate (basic calcium nitrate), prepared from the nitrogen of the air. In this diagram the dark lines unite materials which should never be mixed, the double lines those which should be applied immediately after mixing, and the single lines those which may be mixed at any time.

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[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] U. S. Dept. Agr., Farmers' Bul. 225, p. 7.

PRINCIPLES OF DRY FARMING.[a]

The importance of extending the productive area of farm lands in the United States has been especially emphasized in recent years, with the result that much land hitherto considered unsuited to farming has been brought under cultivation. In this class are the large areas in the western half of the United States, where the rainfall is deficient. It was evident that if these lands were to be profitably utilized for agricultural purposes other than grazing, new methods of farming must be adopted. With this object in view, this Department and several of the experiment stations situated in arid or semiarid regions have carefully studied the agricultural conditions and possibilities of these regions and made extensive tests of the crops and methods of culture adapted to them. These investigations, as well as the practical experience of settlers on dry lands, have now gone far enough to make it possible to lay down some general principles and to indicate certain methods which must be observed in order to guard against failure in dry farming. The following is a summary of some of the more important facts bearing upon this subject as brought out by recent reports of this work by the Department and the experiment stations:

Dry farming is also called dry-land farming or arid-land farming. It is generally defined as farming without irrigation in regions where the annual rainfall is between 8 and 20 inches. The fact that rainfall alone is not the only moisture condition which determines the crop production of a given locality is indicated by the investigations of the Office of Forage Crop Investigations of the Bureau of Plant Industry of this Department, which states that for the production of such drought-resistant crops as alfalfa, slender-wheat grass, tall-oat grass, and brome grass the "investigations indicate that the minimum rainfall is approximately 16 inches in the Dakotas, 18 inches in Nebraska, 20 inches in Kansas * * * and up to 30 inches farther south." In other words, to produce a given crop the amount of rainfall necessary is much greater in the warmer regions, where evaporation removes so much moisture.

Dry farming is made possible in two ways: (1) By careful tillage, and (2) by the introduction of drought-resistant crops or drought-resistant varieties. Even where dry farming is followed, irrigation is usually recommended for the small areas to be devoted to garden crops to carry the household through years of crop failure, which are

[a] Compiled from Montana Sta. Bul. 74; Nebraska Sta. Bul. 109; Washington Sta. Popular Bul. 15; Wyoming Sta. Bul. 80. See also U. S. Dept. Agr., Farmers' Buls. 262, p. 15; 329, p. 10.

more frequent in these semiarid regions than in regions where the rainfall is greater.

The principles of tillage are almost exactly the same as for other regions, or even for the semiarid regions where irrigation is practiced, with emphasis laid upon the conservation of moisture: (1) Because the supply is low, and (2) because one and one-half times as much water is required to produce a pound of dry matter in the plant in these drier regions as is required in more humid climates.

Surface cultivation is constantly resorted to in order to maintain a mulch or lid to prevent the escape of mositure and to keep down weeds, which drain the land of its water. This mulch is renewed as soon as possible after each rain, but should not be made sufficiently fine to allow the wind to blow the soil from place to place. This is especially to be guarded against on sandy soil, which should be worked sooner after rain has destroyed the mulch than the clay soil, which is more inclined to puddle, bake, or otherwise get out of good physical condition. The third advantage arising from frequent surface cultivation is the admission of air to the roots of the crops supplying them with oxygen. This air also encourages the growth of the friendly bacteria which prepare plant food by breaking down humus and forming the nitrates which can be readily taken up by the roots of the plants.

Small shovels are usually preferred to larger shovels: (1) Because they do not ridge the soil and so leave a smaller surface to give up moisture to the sun and winds; (2) the greater number of shovels stirs the soil more uniformly in the shallower zone reached; and (3) because of their failure to go as deeply as the larger shovels there is less danger of root pruning. The disadvantage of the small shovel arises from its lack of efficiency in killing larger weeds.

In extreme cases it is necessary to store up two seasons' rainfall to be used for a single crop. This is usually done by summer tillage or clean summer-fallow, which differs from the old system of summer-fallowing in allowing the land to lie for a longer period unused, and in the more perfect maintenance of the surface mulch and exclusion of weeds. Summer tillage not only stores the water for future use, but also brings the soil into the best physical condition for the reception of the fall-sown crop, which is most frequently recommended for the semiarid regions.

The North Platte Station in Nebraska finds that summer tillage will store water weighing 15 per cent or more than one-seventh as much as the upper 6 feet of the soil. This is equivalent to about 14 inches of rainfall, and will give a fair crop of wheat even with a very low rainfall the following season. During the season of 1908 this station was able to hold only 50 per cent of the rainfall.

The Washington Station has found that 40 bushels of wheat per acre can be produced with 12 inches of water, and that if 50 per cent of the precipitation for two years can be saved a yield of 30 bushels per acre can be obtained with an annual rainfall of 10 inches upon the same land which produced 40 bushels with 12 inches of water and under equally favorable conditions. Fifty bushels of wheat were similarly produced by saving the same percentage of a 15-inch annual rainfall. The comparative results of continuous cropping and summer fallowing, as obtained in Montana, are best summarized by the following table:

Average results for all years tested.

Substation.	Kubanka spring wheat.		White hull-less barley.		Sixty-day oats.	
	Grown continuously.	After fallow.	Grown continuously.	After fallow.	Grown continuously,	After fallow.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Dawson County	15.18	17.57	15.97	20.90	31.17	51.00
Rosebud County	16.98	20.80	15.02	28.31	30.21	40.03
Yellowstone County	7.73	19.32	14.90	20.33	13.75	47.94
Chouteau County	14.18	17.35	13.29	11.95	28.90	34.56
Average	13.52	18.76	14.79	20.37	26.01	43.38

The percentage of rainfall retained will vary from season to season, and depends: (1) On the rate of rainfall during a given storm, (2) on the condition of the soil, (3) on the treatment of the soil following the rain, and (4) on the amount of humus or decayed organic matter in the soil. In a heavy storm the percentage of water escaping as "run-off" is very high, while the same is true on a hard uncultivated surface or one on which the surface mulch has not been restored since the last rain. Showers that do not penetrate beneath the surface mulch are soon taken up again by the sun and winds, but serve to reestablish the hard surface which draws moisture from beneath. So these light showers are a damage except in case of crops nearly ripe or undergoing a period of drought. In case of drought their chief advantage is to check the evaporation from the leaves of the plants rather than to feed the thirsting plant through its leaves, as is sometimes believed. To increase the ability of the soil to hold moisture, thin top-dressing of strong manure chopped or cut into the soil by means of a disk is recommended.

Summer tillage is especially recommended for fall-sown crops rather than those which would require the land to lie bare to the winds through the winter. It has yielded a profit in the case of oats, spring wheat, and barley. A short period of summer tillage is recommended

for alfalfa to be sown in July or August as better than planting earlier on a land foul with weeds or drained of moisture by a previous crop. The most pronounced advantage of summer tillage has been realized with fall-sown wheat. In 1907 the North Platte Station in Nebraska obtained an average yield of 59 bushels per acre on 4½ acres of summer-tilled land, while an adjacent plat not summer tilled produced only 24.4 bushels per acre. Other land not under the control of the station averaged from 15 to 20 bushels per acre.

For summer tillage in western Nebraska, stubble land should be double-disked immediately after the removal of the grain crop to prevent the escape of moisture and growth of weeds. As soon as the frost is out of the ground the following spring it is again double-disked and the surface kept loose and free of weeds by the alternate use of the disk and tooth harrow until June, when the land is plowed 8 inches deep. This gives a deep mulch capable of receiving and retaining a large amount of rainfall. The surface mulch is then maintained without pulverizing the soil sufficiently to allow it to drift with the wind until the desired crop is to be sown.

A deeper mulch is required by "a fine, heavy soil," because it is more difficult to keep open than the sandy soil. The deep mulch is not so readily destroyed by light showers and therefore requires less frequent renewal. It is more efficient than the shallow mulch in keeping down weeds. A mulch 3 to 4 inches in depth can usually be maintained by the use of the spike-tooth harrow and the disk. It is usually sufficient to renew this mulch within a reasonable period after each rain, but during a prolonged drought it should be renewed more frequently.

Although the surface mulch is maintained it is of advantage to have the soil beneath sufficiently firm to draw water from the soil still lower, in order that it may be held at this point available for the roots of the plant without being allowed to escape to the air above. Subsurface packing also causes stubble straw or coarse manure to decay more rapidly by bringing them a greater amount of moisture. This subsurface packing is accomplished either by a special tool, known as a subsurface packer, or by a disk well weighted and run straighter than where the purpose is to stir the soil, thus enabling it to penetrate more deeply and pack the soil immediately below the surface. An extra horse may be hitched on the plowed side, thus rendering more firm the soil over which it walks, or reestablishing the surface mulch by dragging a section of harrow after it.

Since summer tillage has a tendency to exhaust the humus of the soil and so reduce its plant food and water-holding capacity, it should be resorted to only in connection with a rotation that will overcome

26127—Bull. 388—10——2

these tendencies. A rotation recommended for localities where the crops thrive well is "summer till and sow winter wheat; disk and fall plow the wheat stubble for corn the next year; disk the corn stubble for a spring grain—oats, wheat, or barley; apply manure during the winter; disk in spring and plow for [sorghum] cane, which crop completes the rotation." Another means of restoring the humus content of the soil is by turning under green crops of rye and cowpeas or other green-manuring crops. This method has given almost the same advantages as summer tillage, at the same time enriching the soil by the addition of humus, but in very dry years trouble may be encountered through lack of sufficient water to rot the large amount of vegetable matter turned under.

The principles governing drought resistance in the crops or varieties best suited to dry-land agriculture are less perfectly understood than are those of the tillage problems involved. The drought-resistant plants generally have one or more of these properties: (1) The ability to root deeply and obtain water from the lower strata of the soil, (2) the ability to grow rapidly and mature during the season of greatest rainfall, (3) the ability to resume growth after withstanding a period of drought, or (4) in a more limited number of cases to prevent excessive evaporation by a small leaf surface or a glazed surface, as in the case of the cacti.

The crops that have given the best results in Montana are flax, brome grass, barley, wheat, potatoes, corn, and alfalfa. Thin seeding is quite generally recommended. Flax is best adapted for use as a first crop on spring-broken dry-land sod. It has shown an average yield of over 12 bushels per acre in all tests. Brome grass gives a higher yield than any other forage crop reported, giving a hardy growth and an abundance of good hay. Tall-oat grass is slightly below brome grass in yield. Alfalfa has as yet given very low results at these stations, but only one year's work has been reported. Kubanka, Ghirka, and Glyndon wheats seem well adapted to dry-farm conditions in this State and are freely used for bread-making purposes. Turkey Red fall wheat has given a higher yield than any other sort grown. A higher average yield has been obtained from fall-sown crops than from spring-grown crops. White Hull-less barley has been the earliest variety to reach maturity. Corn has yielded 4.44 tons per acre on one of the experimental farms of Montana, indicating its ability to yield forage under dry-farm conditions. An average yield of 124 bushels of potatoes per acre proved this crop a success on the farms of this State, but sugar beets failed to grow readily enough to make them a commercial success, although profitable to add succulence to the rations of the farm animals. Intertillage of crops has

shown an absolute decrease on these farms of about 7 bushels per acre in the case of wheat.

The Wyoming Station has obtained good results with the same crops under its conditions and adds to these winter rye, spring rye, oats, spelt, sugar beets, and in the lower altitudes milo maize.

In western Nebraska good results have been obtained with winter wheat, spring wheat, oats, barley, emmer or spelt, corn, sorghum, Kafir, milo, brome grass, and in the valleys alfalfa has proved a most valuable forage crop, but its success on the table-land is more doubtful. Throughout these semiarid regions 3 to 5 pecks per acre have given better results in the case of small grains than seeding at higher rates. The work of the Office of Forage Crop Investigations has shown good results from the use of Siberian millet sown in the fall on summer-fallowed land, of barley used in the spring as a catch crop, and of the various sorghums experimented with. The Sumac sorghum has proved the sweetest and heaviest yielding variety as far north as the Kansas-Nebraska line. North of this point Red Amber sorghum matures earlier and produces a heavier tonnage of better feed than is secured by the growth of millet. The Kafirs produce more seed and less sugar than the Sumac sorghum and are adapted to the same region. They have the ability of suspending growth when the moisture supply is shut off and resuming it when the drought is over.

Cowpeas have succeeded well in the eastern portion of the dry-farming region when cultivated in rows 3 feet apart. They are less drought resistant but also less subject to the attacks of rabbits than are soy beans. The Bonavist (*Dolichos lablab*) is still more drought resistant, as is also the Kulthi (*D. biflorus*). The latter is the best legume for hay production experimented with at Chillicothe, Tex. The moth bean (*Phaseolus aconitifolius*) is successful but less valuable than Kulthi. Alfalfa requires at least 15 inches of rain in the Dakotas or 24 inches in Texas for successful growth when broadcasted. If cultivated in rows it may be made to produce profitable crops of seed with still less rainfall. Melilot or sweet clover is a good soil improver and of value for forage on sandy or moderately alkaline soils.

As pointed out in previous articles on this subject, too much emphasis can not be laid on the importance of supplementing dry farming with at least enough irrigated farming to insure garden products and forage for stock as a protection against possible failure on the dry land, because whatever the methods adopted, there are likely to be seasons when total or partial failure will be inevitable. The meteorological records of the dry regions as a rule show that wet and dry years occur in cycles and that seasons of excessive

drought occur when, except by means of irrigation, little or nothing in the way of cultivated crops can be grown.

The Office of Experiment Stations of this Department has been investigating for several years the possibility and best methods of irrigating small areas in dry regions in connection with the farming of larger areas without irrigation. It has been found that although the greater part of the land lying between the one hundredth meridian on the east and the Rocky Mountains on the west is beyond the reach of canals from the streams of that section, and the water supply is not sufficient to irrigate any considerable part of it, by means of wells with pumps and tanks; small storage reservoirs to catch storm waters coming down coulees, draws, and small stream beds; intercepting ditches across broad slopes directing the run-off to the orchards or fields below; and the use of the soil and subsoil to store the storm waters of spring freshets, a sufficient amount of water may generally be provided to carry at least a portion of the crops over a period of excessive drought and thus make the difference between partial success and total failure.

METHODS OF SEEDING OATS.[a]

For the period 1903–1907 Iowa produced an average annual yield of 123,422,880 bushels of spring oats on 4,144,463 acres, or an average of 29.5 bushels per acre, valued at about 29 cents per bushel. Figures presented for Illinois show an annual yield of 112,200,000 bushels from 3,400,000 acres, averaging 33 bushels per acre and bringing 32.2 cents per bushel on the market, or a total of $10.63 per acre. Of this return $5.45 is consumed in the items of cost, sowing with a broadcast seeder, seed, disking once, harrowing twice, harvesting including twine, shocking, threshing, and marketing, leaving a gross profit of $5.18 per acre. This is insufficient to pay taxes and 5 per cent interest on $100 land. If cost of maintaining soil fertility, wear of machinery, and of additional labor involved, be considered, this gross profit is reduced to $3.33, or enough to pay taxes and 5 per cent interest on $60 land. At the present average yield, oats are profitable only because required in rotations or as a nurse crop. A large percentage of corn-belt farms can average 75 bushels per acre, in which case a profit of more than 20 cents per bushel, or $15 per acre, would result, and the oat crop would be profitable aside from its value in rotations. Among the more obvious and practical means of raising the present average are: (1) Improved methods of seeding, and (2) treatment for the prevention of smut preliminary to seeding.

[a] Compiled from Illinois Sta. Bul. 136; Iowa Sta. Bul. 96; Kansas Sta. Bul. 74.

Loss due to smut is usually overlooked: (1) Because largely concealed by the shortness of the smutted stalks as compared with the healthy ones; (2) by the fact that many of the smutted heads do not push out of the sheaf leaves and so pass unobserved, and (3) because the smut has usually ripened and scattered its spores to infect the soil and neighboring healthy oats for the ensuing year before the normal plants have ripened their grain. The loss due to this cause in Illinois has been found to vary from one-fourth of a bushel to 13.25 bushels per acre, with an average amount of smut in oat fields of over 13 per cent. This loss can be almost entirely prevented by treating the seed with formalin at a cost of about 2 cents per bushel. Tests have shown that where 93 per cent of the plats sown with untreated seed produced oats with from 1 to 20 per cent of smutted heads, only 44 per cent of the plats sown with treated seed were infected with smut at all, while no treated plat had more than 1.2 per cent of smut. The formalin and other methods of preventing grain smuts have already been fully described in the publications of this Department.[a]

Of 452 Iowa farmers replying to circular letters, 96.6 per cent were found to plant oats on stalk ground, only 3.5 per cent raked and burned stalks, while 71.7 per cent did not break, harrow, or burn stalks, 70 per cent disked after sowing, 13.3 per cent before sowing, and 16.7 per cent both before and after sowing, 97.5 per cent harrowed after sowing, 11 per cent before sowing, and 9.2 per cent both before and after sowing. A seed bed more than 3.5 inches deep is not necessary for the oat crop because it is a surface feeder and responds quickly to a firm seed bed.

At the Kansas Station the average results from the eight years' trial of spring and fall plowings were almost equally good. Of successive sowings, about March 2, 9, 16, etc., until May 3, made with the press shoe drill at the rate of 3 bushels per acre, that of March 9 gave the highest average yield for the years when it produced a crop, but on one occasion it was lost by freezing. Sowings made April 20 and 27 were total failures one season. Seed from which the light oats had been fanned out produced an average yield during an eight-year test of 1 bushel more per acre than did similar seed not fanned, and nearly 3½ bushels more than did the light seed fanned out. The heavy seed produced more stalks. The highest yield per acre resulted from a seeding of 4 bushels, while Canadian experiments have obtained the highest yields from a seeding of 3½ bushels in one instance[b] and of 2⅛ bushels in another.[c] Surface-plowed

[a] U. S. Dept. Agr., Farmers' Buls. 225, p. 12; 250, pp. 8, 9, 13–15.
[b] Canada Expt. Farms Rpts. 1908, p. 347.
[c] Canada Expt. Farms Rpts. 1908, p. 385.

land produced about three-fifths of a bushel more per acre than land subsoiled for corn the season prior to that in which it was sown to oats. Where a liberal coat of manure had been plowed under in the fall, both land packed once with a subsurface packer and that packed four times produced approximately 4 bushels more than the unpacked land. Under the same conditions, on spring-plowed land a still greater increase of yield was secured by the use of the packer. The land packed once showed an increased yield of more than 4½ bushels and that packed three times showed an increase of 7 bushels, as compared with the yield on the unpacked land. During this test the supply of moisture was abundant. Presumably a still greater benefit would have arisen from the packer in a dry or unfavorable season, as its object is to compact the soil, so retaining the moisture and supplying it more readily to the seed. At Lacombe, Canada, oats on packed soil yielded over 85 bushels per acre, while those on unpacked soil yielded 66 bushels and 30 pounds.[a]

Perhaps the most practical seeding method of increasing the yield of oats is the use of the drill instead of the broadcast seeder. At Urbana, Ill., in 1905 the average difference in yield between oats planted with the drill and those planted with the broadcast seeder was 12 bushels, and on each of the 18 plats it was in favor of the drilled portion. In 1907 the difference was in favor of the drilled oats in 11 cases, in favor of the broadcast oats in 5 instances, while on the remaining 2 the yields were exactly equal. In 1908 the drilled oats were planted at the rate of 2 bushels per acre and the broadcast sowing made at the rate of 3 bushels. Out of 30 sowings made, 18 yields favored drilling, while 9 favored broadcasting, and in 3 cases the yields from the two methods were exactly equal. The average yield from drilling was 1.6 bushels greater than that from broadcasting, which, together with the saving in seed, gives this method an advantage of 2.6 bushels. It is seen that the weather conditions during the growing season make a great difference as to the relative yields obtained by these methods. Similar tests at De Kalb showed a net average of 2.7 bushels in favor of drilling as compared with broadcasting. The most marked difference at this station was shown on timothy sod, where 4 bushels per acre represented the advantage of the drilled oats over those sown by broadcasting. For two years at another point, land previously in corn, seeded to clover at the last cultivation of the corn, and planted to oats in 1906, showed an average difference in yield of 3.6 bushels per acre in favor of the drilled fields.

It has been found that plowing does not take the place of drilling, but that the advantage of drilling over broadcasting is even more

[a] Canada Expt. Farms Rpts. 1908, p. 348.

marked upon plowed land than upon land disked before seeding. Plowing the land produced an increased yield of 2 bushels per acre, which was insufficient to pay for the difference between the labor of plowing and that of disking. In some instances the impossibility of harrowing in the oats immediately after they are broadcasted emphasizes the advantage of the drill, which both plants and covers at the same operation. The 3 Illinois fields quoted are representative of widely differing conditions, and show an average difference in yield of 3.9 bushels per acre, indicating the possibility of increasing the production of oats in this State alone by over 13,000,000 bushels annually, without any increase in acreage or improvement in other particulars. At the market price of 32.2 cents per bushel, this would mean an increased income of more than $4,000,000 to the oat producers. The increase in yield on 35 acres, it has been estimated, will pay for a drill in a single year. The difference in cost of sowing is almost nothing, as the experience of careful farmers indicates that the time and labor required to drill land is practically equal to that required in harrowing it once and going over it with a broadcast seeder. "This would certainly represent the minimum of work that could be done in each case. If, besides this, the broadcast land needs to be disked, while the disk-drilled land needs only to be harrowed, the drilled land would require less expense." A drill properly cared for "should not cost over $2.50 to $5 per year, depending upon size of drill and amount of land sown. * * * The question will likely arise as to what kind of drill to use. To this it is only necessary to reply that the only practical kind for corn-belt farmers is some good make of disk drill. The disk drill is the only kind we know that will not clog in going through an ordinary amount of cornstalks or other refuse on land. A good disk drill will do this without much trouble. Perhaps the disks should be 8 inches apart rather than closer together for this mechanical reason."

A three years' comparison of drilling and broadcasting oats by hand at the Ontario Experiment Station Farm at Guelph, Canada, showed an average difference in yield of 4 bushels in favor of drilling during the three years of the test. At the Iowa Station, oats planted by the disk drill yielded 44.9 bushels of oats, weighing 23.5 pounds per bushel, while those broadcasted yielded 35.3 bushels, weighing 21.5 pounds per bushel.

The reason for the increased yield resulting from drilling oats is shown by careful study of the young plants. It is observed that they are planted at a more uniform depth, that none are left on the surface of the soil exposed to the drying of sun and winds or the action of freezing weather, that the soil is more closely pressed about them, and that germination is more prompt and uniform, and that the

patchy appearance somewhat common to oats sown by hand or otherwise broadcasted is overcome. When the rows of oats run north and south, young clover receives more sunlight, and is better able to endure the hot sun when the oats are harvested. The comparison of the use of the disk drill and the broadcast seeder in planting oats shows these advantages for the drill: (1) Increased yield per acre, (2) economy of seed, (3) uniformity of stand, (4) a greater uniformity in regularity of growth and time of heading and ripening, (5) less harmful influence on young clover when the oat crop is removed, and (6) equal or greater economy in cost of labor in seeding.

ROLLING VERSUS HARROWING WINTER WHEAT.[a]

The Nebraska Experiment Station has been carrying on for several years (1902–1906) at Lincoln comparative tests of harrowing and rolling winter wheat, an account of which is given by E. G. Montgomery in a recent bulletin of the station. Plats were seeded to Turkish Red winter wheat, some sown broadcast, others put in with a press drill. Some of the plats were harrowed in both fall and spring, others were harrowed only in the spring, while a third set was rolled.

It was quite evident from the results that no benefit was derived from the harrowing. In fact "harrowing broadcasted wheat resulted in an average loss of almost 3 bushels per acre, while harrowing drilled wheat resulted in a loss of nine-tenths of a bushel per acre."

It is suggested, however, that the harrowing, on account of its influence in conserving moisture, might be beneficial in drier regions or seasons. As a whole there was no lack of moisture during the years in which these experiments were made, but "in the two seasons when spring rainfall was below normal (1905 and 1906) there was some increase from cultivation."

The results from rolling were conclusive. In no year did it fail "to give an increased yield, the average increase being 5.1 bushels per acre."

> The rolling was given early in the spring, soon after frost was out, and about the time growth started. Harrowing after rolling was not as good as rolling alone, probably due to loosening up the plants again after the roller had pressed them firmly into the soil.
>
> Early spring rolling of winter grain, pressing the earth as it does firmly about the plant roots, produces good results. When frost comes out in the spring it is very apt to leave the soil filled with small cracks or checks, especially around the plants [fig. 2]. If these checks are examined closely, it will be seen that a large number of roots are thus exposed, and if the weather continues dry they are killed or at least injured. * * *
>
> If the soil is not wet at the time of rolling—and it should never be rolled when wet—rolling aids in no small degree to form a surface mulch.

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[a] Compiled from Nebraska Sta. Press Bul. 30.

The Nebraska Station experiments, therefore, point quite clearly to the conclusion that under ordinary conditions of normal seasons in humid regions winter wheat is sufficiently benefited by rolling to

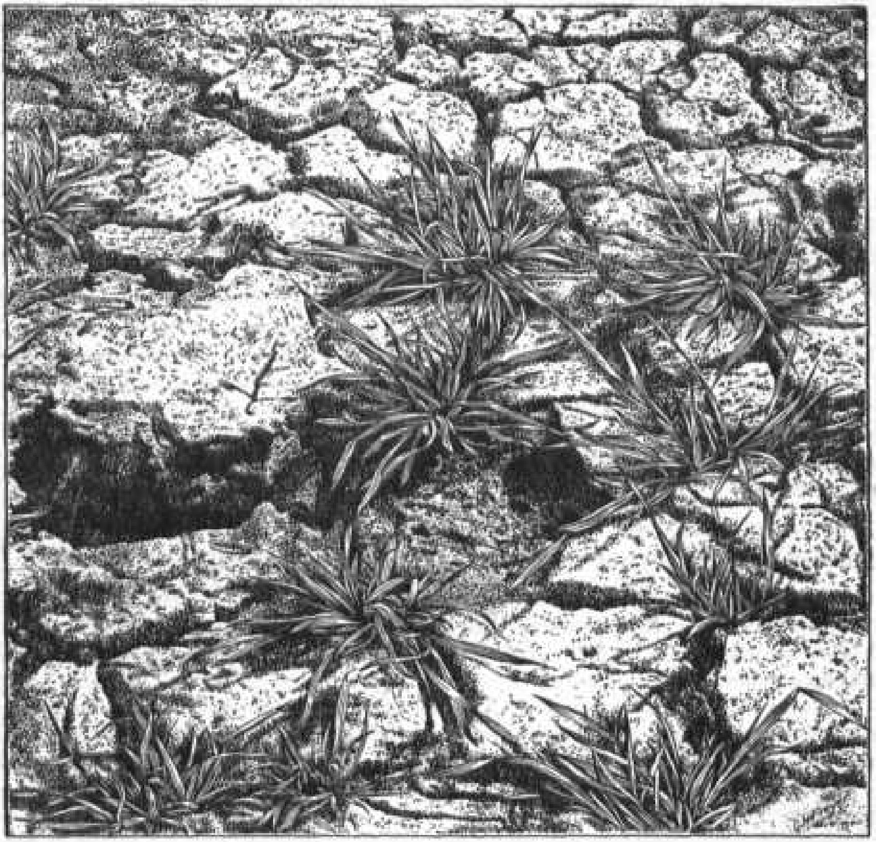

FIG. 2.—Appearance of the surface soil of a wheat field in spring.

make the practice profitable, while harrowing is not to be recommended under such conditions.

DESTRUCTION OF EELWORMS IN GARDEN AND GREENHOUSE SOIL.[a]

Eelworms or nematodes in garden and greenhouse soil constitute a serious and troublesome pest for which it is extremely desirable to find some simple and practical remedy. Experiments on various methods of destroying eelworms have been carried on for many years by G. E. Stone, of the Massachusetts Experiment Station, and a

[a] Compiled from Massachusetts Sta. Rpt. 1908, pt. 1, pp. 56-61. See also U. S. Dept. Agr., Farmers' Buls. 186, p. 8; 259, p. 9.

recent report of that station gives some of the practical results of these experiments.

As Doctor Stone points out, the use of lime is often advocated for destroying the eelworms, but his experiments show that lime has little or no value for this purpose. In fact, it was found possible to keep eelworms alive for several days in a saturated solution of lime-water. "Undoubtedly the application of lime to greenhouse soil improves it by modifying its acidity, but eelworms will thrive in soils which are not acid."

The use of formalin has been recommended, but the experiments at the Massachusetts Station indicate that this is not effective in killing the worms, and besides can not be used on soils containing growing plants on account of the injury likely to result to the plants.

Of late years formalin has been recommended as a remedy for eelworms on violets. This is used by applying it to holes made in the soil where the plants are growing. The formalin being volatile, the gas penetrates the soil and is said to kill the worms. Our experiments with it would not seem to warrant the use of this method of treatment, as formalin is injurious to plants, and there is reason to believe that it would not affect in the least the eggs of eelworms, which are fairly well protected by a resistant covering.

The methods used with more or less success at the Massachusetts Station for destroying eelworms in greenhouse soils were as follows:

Sterilization.—This is one of the cheapest and best methods of destroying eelworms in greenhouse soil. It is necessary that the soil be heated to at least 180° F., and a higher temperature is better. This is accomplished by driving steam through the soil by a system of perforated pipes.

Freezing.—If the soil is frozen for any length of time the eelworms are destroyed, and some use has been made of this method by practical growers. As a rule, the soil is removed from the house and frozen in bulk out of doors.

Desiccation.—Drying the soil is destructive to eelworms, but it is difficult to dry soils sufficiently in deep benches to make this method effectual. The application of unslaked lime, however, will materially aid in drying the soil, by virtue of the water-absorbing qualities of the lime. * * *

Trapping, or the catch-crop method.—It has been found in Germany that sowing very susceptible crops, like mustard or rape, on soil contaminated with eelworms, and, after the females have become encysted in the roots, pulling up the plants and exposing them to the drying rays of the sun, is capable of reducing the worms to some extent in contaminated soils. We have found, however, that two or three catch crops are much better than one.

The Massachusetts experiments indicate that in some instances simply flooding the soil may prove a successful means of destroying the eelworms, and that manure infected with eelworms may be safely used on garden and greenhouse crops if left for a sufficient length of time in water.

PRUNING.[a]

As the season approaches when pruning must be done, if attempted at all, it may be worth while to consider briefly the importance and advantages of this practice. These are strongly set forth by O. B. Whipple in a recent bulletin of the Colorado Experiment Station, as follows:

Many and varied are the excuses offered by the man who owns an unpruned orchard; he is ashamed of the neglected trees and tries to justify himself by advancing what he considers, or more likely what he tries to persuade himself, is a good reason. One holds that pruning is little short of sacrilege, contrary to the laws of nature; another tells of his fond recollections of childhood and what excellent fruits he picked from the old apple tree, pruned alone by nature; another says it does not pay, and in his particular case it does not, for the chances are that the orchard is neglected otherwise. The only excuse that has any semblance of justification is that of ignorance, and that does not excuse the man who makes no attempt. Nature's object is the production of seed with provision for its distribution, and she is satisfied when a cherry is produced with enough flesh to attract some fruit-loving bird that may, perchance, drop the seed far from the parent tree. Man grows the fruit for its fleshy parts and tries to improve these parts as much by placing the plant in a more favorable environment as by plant breeding and selection. * * * The man who can not afford to prune can not afford to grow fruit, and the man who does not know how to prune must learn; the principles are not complicated.

The general principles which should guide in intelligent pruning are concisely stated by Professor Whipple, as follows:

Physiology of pruning.—To be an intelligent pruner one must know something of plant physiology. He should know the effects produced by pruning at different seasons of the year, how to make a cut that will heal most readily, and the influence of pruning on the fruit-bearing habit of the tree. * * * It is generally conceded that pruning during the dormant season incites wood growth, while pruning during the growing season promotes fruitfulness. * * *

Although it is said that pruning during the summer season may encourage the formation of fruit buds on tardy-bearing varieties, it may have the opposite effect, unless done at the proper time, and may cause late growth and unfruitfulness. To give the desired results one must summer-prune shortly before the season of growth ends; earlier pruning starts new growth, while late pruning gives no results. The benefit derived from summer pruning seems to depend upon the ability of the pruner to prune at a time to bring about early maturity. In an irrigated section, where soil conditions are easily controlled, the same end may, no doubt, be more easily attained by proper manipulation of the irrigation water.

Both the season at which the wound is made and the character of the cut have an influence upon the healing process. The pruner should remember that all food material capable of healing a wound is taking a downward course through the inner bark, and that to heal well a wound must be in a position to intercept the downward flow of sap from foliage higher up. When a limb is to be removed entirely, the cut should be at the union with and parallel to the surface from which the limb arises. Where limbs are to be headed back, they should be cut to a side limb and not to a bare stub. Wounds naturally heal best when made at a season of the year when growth is

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[a] Compiled from Colorado Sta. Bul. 139.

most active, but with the possible exception of wounds made in early winter and subjected to a long season of drying, the season at which the wound is made has no important bearing upon the healing process. The grower who has a small orchard that will permit of such a practice should delay the pruning until as near the opening of the growing season as possible.

The influence of pruning upon the fruit-bearing habit of the tree has been briefly mentioned, but * * * a fruit-bearing habit may, to a certain extent, dictate a course in pruning. The fruits with which this discussion has to deal have two general types of fruit bearing—from terminal fruit buds and from axillary fruit buds. The first type of fruit bud is well represented in the apple and pear, and the latter in the stone fruits. Trees which produce axillary fruit buds are naturally more prolific and require severe pruning as a means of thinning the fruit. In fact, a system of pruning under which the tree with axillary fruit buds would thrive would cause the apple tree to overgrow to such an extent that it would be rendered almost barren. The point may be more fully illustrated by comparing the peach and the cherry. Although both develop axillary fruit buds, they differ in their fruiting habits; the fruit buds of the cherry are seldom found on the stronger growing new wood, and severe pruning, as practiced on the peach, would throw much of the strength of the tree into the production of strong wood that would carry very few fruit buds. We have said that in the apple the type of fruit bearing is from terminal buds, yet many varieties develop axillary fruit buds. Varieties which develop axillary fruit buds and bear terminal fruit buds on young spurs all tend to overbear, and require severe pruning. So to a certain extent one can decide for himself how much to prune by observing how the tree bears its fruit.

Treatment of wounds.—The argument in favor of dressing wounds is that it prevents decay and checks evaporation, both of which might interfere with the healing process. While in our arid climate the first is hardly applicable, the second should probably be doubly important. Yet, the matter of dressing wounds is not so important but that work improperly done is worse than no treatment. A good lead paint is one of the most satisfactory dressings yet found. Rather a thick paint should be used, and careless daubing of the surrounding bark should be avoided. Grafting wax is a good dressing, but is rather expensive and difficult to apply. Other materials have been used, some successfully and some disastrously, and the grower is to be cautioned about experimenting; better stick to materials known to be safe and efficient. Growers often overdo the matter and waste time treating small wounds. Surely a wound less than 1½ inches in diameter is not worth bothering with.

These suggestions apply to wounds made by the careless cultivator, as well as those made by the pruner. Unsightly wounds and permanent injury may often be avoided by proper treatment of trunk wounds. When the body of the tree is injured, the ragged edges of the bark should be pared off to sound tissue and the whole injury covered with paint or grafting wax. If promptly done, this prevents drying out of the tissues, and new bark will readily form, except on parts where the outer wood cells are actually destroyed, and in time this will grow over. Wrapping the injury with cloth, or if it is near the ground mounding earth up over it will often answer the same purpose.

Pruning tools.—Every pruner should be furnished with good tools; good tools encourage him to do good work. This does not necessarily mean that he must have every tool on the market. Many of them are useless. It does mean, however, that the ax and a dull saw have no place in the catalogue of pruning tools. The pruner needs a good saw, a good pair of light shears, a pair of heavy shears, possibly a good heavy knife, and, of course, a good ladder. Two common types of saws are found on the market. The common saw with teeth on both edges is a good, cheap one and will

answer the purpose in many cases. Tho various makes of tho swivel saws are much handier, howover. The blade is stretched between swivels and can be turned to any angle with reference to the frame. It is well adapted to close work in the crotches of the tree. This type of saw can generally be bought for $3. The blades are not so frail as they look and seldom break, if properly handled. They can be replaced at a cost of 50 cents. It is really the best type of pruning saw and should be more universally used.

A good type of hand shears is indispensable for light work. Various makes are on tho market; buy the one that appeals to you. A pair of heavy shears is almost as essential; they take the place of the saw in many cases and will do the work in less time. They are used in heading in limbs where the saw can hardly be used; the peach pruner finds good use for them. They work well on limbs up to 1½ inches in diameter. The only objection the writer has to this tool is that the pruner sometimes gets careless and leaves stubs. There is a type of heavy shears on the market that has two cutting edges instead of one, but it seems to do no better work. The pruner finds very little use for a knife in pruning mature trees and seldom carries a special pruning knife. Several types of the long-handled tree pruners are on the market, but they are of little value in the orchard. The pruner should be close to his work, and with a good ladder and short-handled tools he will do better work.

The principles and practice of pruning are discussed in detail in a Farmers' Bulletin of this Department,[a] prepared by L. C. Corbett, and the reader is referred to that bulletin for practical directions regarding the pruning of fruits, ornamental plants, and street and timber trees.

BEAN ANTHRACNOSE OR POD SPOT.[b]

Nearly everyone is familiar with the spotted appearance of snap beans, especially of the wax-podded varieties. This all too common disease has been known for many years and a good description has been given of it by Beach[c] and Halsted.[d]

The disease, which is of fungus origin, goes under a number of names, as rust, wilt, pod spot, etc. As there is a true rust and a wilt, caused by bacteria, the name pod spot or anthracnose is preferred for it.

Practically all parts of the bean plant except the roots are subject to attack of the fungus. The most common indication of the presence of the disease is the occurrence of brown or black sunken areas on the stems, leaves, and pods. They may also appear on the seed leaves (cotyledons) and stems of the plant soon after it appears above ground and cause considerable losses through a reduction in the stand. On the older plants the attack is most serious on the larger veins of the leaves, and the leaf may be wholly destroyed or

[a] U. S. Dept. Agr., Farmers' Bul. 181.

[b] Compiled from Louisiana Sta. Bul. 116; New York Cornell Sta. Buls. 239, 255; Insect Pest and Plant Disease Bur. Nebr., Div. Bot. Circ. 6.

[c] New York State Sta. Bul. 48.

[d] New Jersey Stas. Bul. 151.

its efficiency greatly reduced (fig. 3). From the stems and leaves the fungus spreads to the pods, and as many are rendered unsightly considerable direct loss is occasioned (fig. 4).

The presence of the fungus is often unnoticed until it appears upon the young pods. On these it produces small brown or rusty spots, which enlarge and darken until they become nearly black. The affected tissues of the pod dry, leaving sunken areas, in the centers of which may be seen small pink spots, masses of spores which rapidly spread the disease from plant to plant. The fungus grows by sending fine thread-like filaments into the cells of the bean plant. When on the pods, these filaments often reach the beans within the pod, and unless they are entirely destroyed the dried beans become a means whereby the disease is carried from crop to crop. This is now believed to be the principal means by which the fungus passes the winter, and this offers an important clew as to means for preventing the disease.

FIG. 3.—Anthracnose spots on stem and leaves of the bean just before blossoming time.

Diseased beans may be recognized by the brownish or yellowish discoloration of the seed coats, and when badly affected the seeds will be more or less shriveled in addition to being discolored. When such seed are planted the dormant fungus resumes its growth with that of the plant and the seedlings are soon affected. Some efficient method of seed treatment should reduce the amount of disease, but none is known as yet. Careful hand selection, in which all discolored, shriveled seed are rejected, will reduce the amount of the disease somewhat, but it has not proved a wholly satisfactory method. A better method is selection of seed while still in the pods.

If no spots are to be seen on the pods, the seed will be reasonably free from the fungus and sound seed when planted will give a clean crop. On this account, extra efforts should be made to secure good seed. It has been suggested that seed be grown in uninfested regions,

but dealers can not always be sure of the absence of the fungus from any particular region, the disease having spread to most of the important bean-growing regions.

For the average gardener selection of seed from the growing crop, all spotted pods to be rejected, and care in planting, so as to be away from other areas of beans, will give a clean crop, if a few ordinary precautions are observed. The spores by which the fungus is spread from plant to plant are very sticky when wet and are readily transferred on the hands, clothing, or implements. On this account beans should never be cultivated or gathered while wet with dew or rain. If it is too much trouble to observe these precautions for the whole crop, it could be done with little extra effort for a small plat on which to grow seed for future planting. There is some prejudice in certain quarters against the raising of seed at home, but experiments at the Louisiana Station gave as good results with home-grown bean seed as with that introduced from a distance.

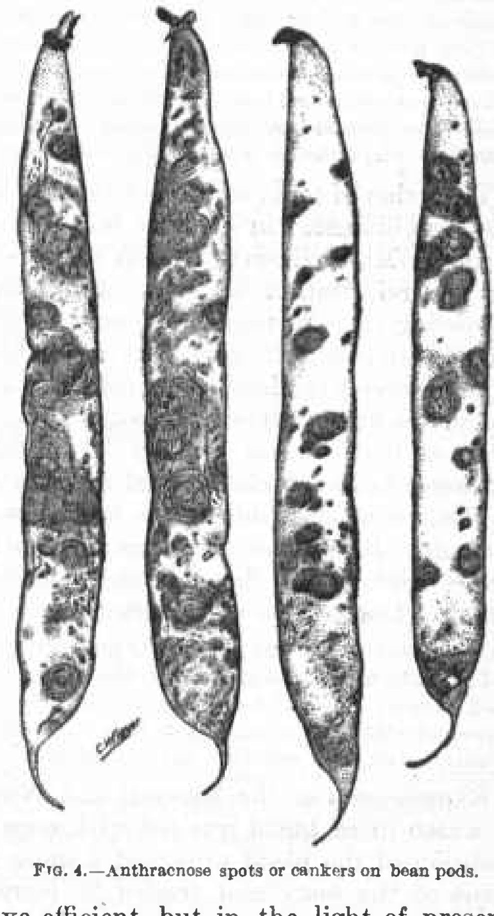

FIG. 4.—Anthracnose spots or cankers on bean pods.

Formerly spraying with Bordeaux mixture or other fungicides was recommended for the control of the pod spot, and if very thoroughly done at frequent intervals it may prove efficient, but in the light of present experience, if the following recommendations are observed, but little loss will result from anthracnose or pod spot:

(1) Plant seed free from disease.

(2) Keep away from the plants while they are wet.

(3) Remove and burn diseased plants as soon as they are observed.

ANIMAL FEEDS FOR FARM STOCK.[a]

The use of various by-products of the meat industry as stock foods has rapidly increased in recent years. As a rule these materials are rich in nutritive matter, very digestible, and furnish an excellent source of protein for farm stock of various kinds. In a report of the Massachusetts Experiment Station J. B. Lindsey says:

> In the United States up to the present time the various residues from slaughter-houses and fish factories have been utilized chiefly as sources of plant food. Of late the large packers have endeavored to popularize such material in place of or as a supplement to protein concentrates of vegetable origin. Large amounts of meat scraps and meals are consumed in the rapidly increasing poultry industry, and several brands of specially prepared or digester tankage and dried blood are recommended and offered for sale, although not generally distributed in local markets.

The value of meat scrap and tankage as feed for pigs and poultry has been discussed in previous bulletins of this series.[b]

At the Massachusetts Station tankage was fed to dairy cows in a mixed grain ration at rates of one-half pound daily, gradually increasing to 1½ pounds. The animals ate the tankage readily when mixed with grains, in spite of its noticeable odor. "Frequent samples of milk were examined, both cold and at a lukewarm temperature, but it was not possible to detect any flavor or odor that could be attributed to the meat product. It is hardly considered advisable, however, to feed such material to dairy stock."

The use of dried blood has not been so fully studied as that of tankage. References to its use as feed for pigs, calves, horses and mules, and poultry have been made in previous bulletins of this series.[c] Doctor Lindsey states that—

> Dried blood for feeding purposes is prepared by heating the fresh blood of cattle and swine in large tanks at 212° F. The excess of water is removed from the coagulated mass by means of heavy presses and the material then passed through steam driers and eventually ground and bagged. As thus treated it appears as a dry, friable powder of dark color and with only a slight odor.

Experiments at the Missouri and Wisconsin experiment stations, in which dried blood was fed with corn to hogs, showed that "the addition of the blood produced a more rapid and healthy development of the body and tended to increase the proportion of lean meat."

Digestion experiments with sheep and tests of the feeding value (as compared with cotton-seed meal) for dairy cows of a sample of blood meal containing 84.64 per cent of protein, 3.18 per cent of ash,

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[a] Compiled from Massachusetts Sta. Rpt. 1908, pt. 2, pp. 149–157.

[b] U. S. Dept. Agr., Farmers' Buls. 169, p. 29; 276, p. 21.

[c] U. S. Dept. Agr., Farmers' Buls. 169, p. 30; 186, p. 26; 222, p. 19; 233, p. 25.

and 0.37 per cent of fat were made at the Massachusetts Experiment Station. The results were in brief as follows:

(1) Dried blood contains some 85 per cent of protein, and when properly prepared (not overheated) has proved itself to be highly digestible and well suited as a concentrated protein nutrient for farm stock.

(2) For cows in milk it may be fed in amounts varying from 1 to 2 pounds daily, mixed with concentrates of vegetable origin. A satisfactory combination for a day's ration consists of 2 to 3 pounds of wheat bran, 2 to 3 pounds of corn or hominy meal, and 1.5 pounds of dried blood. Other mixtures can be made containing blood as a constituent.

(3) It is believed to be the part of economy to first utilize blood as an animal food rather than to apply it directly as a fertilizer.

(4) The present price of prepared blood, its lack of distribution in local markets, and the ignorance of the consumer concerning its merits as a food have thus far prevented its general use for feeding purposes.

The dried-blood ration was about 2 per cent more expensive for milk production and 5 per cent more expensive for butter production than the cotton-seed meal ration, the cost per 100 pounds of milk being with the blood ration \$1.04 and with the cotton-seed meal ration \$1.02, the cost per pound of butter 17.7 cents with the blood ration, and 16.9 cents with the cotton-seed meal ration.

FEEDING THE PIG.[a]

This is the title of an interesting and instructive circular of the Illinois Station giving the results and conclusions from several years' experiments by W. Dietrich. The experiments were begun in 1904 with the purpose of developing a new feeding standard for swine, "or to put the practice of swine feeding upon a fundamental basis and into such form that anybody who can follow instructions may get large and economical gains." By the method of feeding developed as a result of these experiments 40 per cent greater gain in live weight was produced than when the old feeding standards were followed. In the methods proposed particular importance is attached to exercise, to the control of the water consumed, and to supplementing the mineral matter and fat found in ordinary feeds.

A fact that has recently been determined indicates that the influence of exercise upon the functional activities of a pig is an important factor. Hence the lack of exercise is a handicap to the fall pig because during the winter on account of cold weather not so much exercise is usually taken as in the summer, except during very hot periods. For maximum and most economical production it seems absolutely necessary for the young and growing pig to have an abundance of exercise. Its chief value seems to be in the influence it exerts upon the respiratory and digestive functions.

If pigs are changed from lots where they have had considerable exercise to lots where they do not have so much, their feed must be correspondingly reduced. Hence

[a] Compiled from Illinois Sta. Circs. 126, 133.

they will also make smaller and usually more expensive gains. If the weather conditions are such—as, for instance, when it is very cold—that the pig does not take the usual amount of exercise, the ration should also be reduced correspondingly.

The marked benefit derived from pasturage is attributed to the fact "that in grazing the pigs get the needed exercise which stimulates the functions of respiration, digestion, and metabolism, thus enabling them to utilize larger quantities of feed to better advantage. That is, they will make larger and more economical gains from a given quantity of feed, grain, and pasture combined when they have exercise than when they have no exercise."

In order to get best results it is undoubtedly necessary, as shown by the experimental data, to feed the right quantity of water as well as the right quantity of the other nutrients; and * * * another one of the principal reasons that winter feeding of pigs has not been more successful is because an insufficient amount of water was used. During the winter season in cold climates where the pig is given dry feed

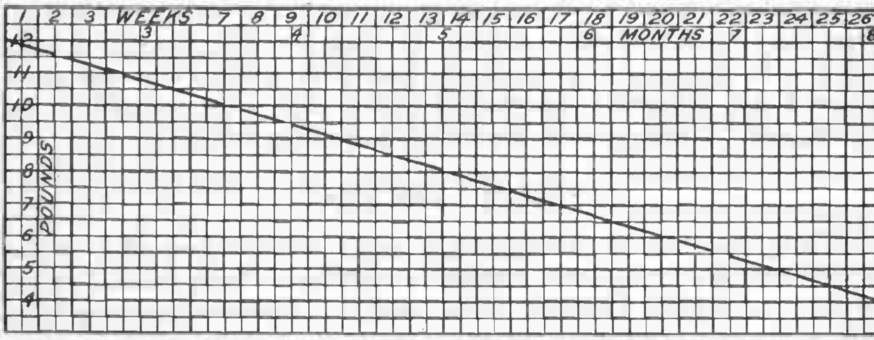

FIG. 5.—Diagram showing the water requirements of pigs at different stages of growth (from 2 to 8 months old).

and free access to water he will apparently not drink enough for maximum and most economical production.

As indicated in figure 5, the water requirement begins with 12 pounds daily per 100 pounds of live weight for pigs two months old and falls gradually to 4 pounds daily for pigs eight months old and in prime condition for market.

In general all the water is given with the feeds in the form of a slop, but a limited amount of recent data seem to show that, in so far as the water is considered in itself, it makes some difference as to how it is fed, as well as the use of the right quantity. The best results have been obtained by feeding the bulk of the water after the rest of the feed has been eaten, using enough water to wet the dry feeds and enough feed in the water to make it palatable. During the hottest weather, however, it seems to be necessary to add a little more water to the dry feed. But the manner in which water is used in a ration may exert considerable influence in other directions, as, for instance, the distribution of the other nutrients, the amount of exercise the pigs get, etc.

By giving the pigs dry feed or a thick slop and then free access to water they did not do as well as in cases where the above-specified quantity of water was mixed with all the dry feeds in the form of a slop. The former method, however, produced better

results in summer than in winter, but was also comparatively ineffective during the hot weather. This, which is also borne out by the data when compared with the water curve, indicates that in winter the pig will not drink enough and that during the hot weather of summer he will drink too much when he is given free access to water.

[In view of the fact that] the amount of mineral matter present in the soil, in the water, in the vegetation, and in different feeds is so decidedly variable, and since there is no standard for the requirement of mineral nutrients by the pig, it seems necessary in order to get best results in feeding to give the pig free access to a variety of mineral substances, so that he can supply, according to the dictates of his appetite, whatever is deficient by way of mineral substances in his feed. In order to

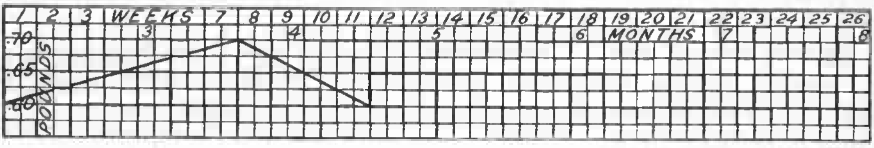

FIG. 6.—Diagram showing the crude protein requirements of pigs at different stages of growth.

supply these mineral substances, the results on the station farm seem to be quite satisfactory if the pig is given free access to salt, charcoal, air-slaked lime, bone meal, wood ashes, clean soil, and soft-coal cinders. These, with the exception of the last two, are kept in different compartments of a trough before the pigs at all times.

Apparently, also, pigs "make larger gains if they are given a little more fat in their ration than is ordinarily present in the common feeds of the farm." It is somewhat difficult to control this factor, but it may in a measure be controlled by using in the ration feeds like soy beans which are rich in fat.

Figure 6 shows the amount of digestible crude protein required by the pig daily per 100 pounds live weight, according to the data determined, for maximum and

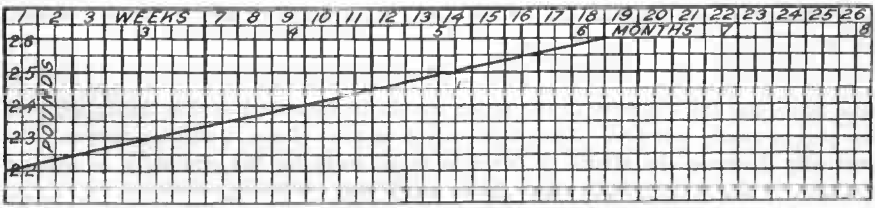

FIG. 7.—Diagram showing carbohydrate requirements of pigs at different stages of growth.

most economical production. The curve starts at 0.6 pound at the beginning of the experiment and rises to 0.7 during the first seven weeks. Following this it declines to 0.6 during four weeks' time, then maintains a level of 0.65 for the next seven weeks. After this the greater part of the nitrogenous feeds are removed from the ration during four weeks' time. Some protein, however, is fed to the close, as pigs will do better if they have more protein than is found in corn. * * *

Figure 7 shows the amount of digestible carbohydrate required by the pig daily per 100 pounds live weight. It will be noticed that starting with the pig at two months of age he should have 2.2 pounds of digestible carbohydrate daily per 100 pounds live weight. After this, as indicated by the curve, it is gradually increased during the following eighteen weeks, when the curve reaches 2.6 pounds.

In the experiments at the Illinois Station "the pigs were usually started at two months of age and fed until they were eight months old, making a feeding period of twenty-six weeks. The carbohydrate curve, as above given, extends over only the first eighteen weeks of the experiment. During the last eight weeks the pigs were put on full feed on a ration that was primarily [carbohydrate] in nature." Later experimental data "seem to indicate that this curve might be raised to good advantage, starting at 2.4 and ending at 2.8 pounds."

The composition of feeds and the compounding of rations are explained in another Farmers' Bulletin of this Department,[a] and will not be discussed in detail here.

In order to get large and economical gains it is recommended to use as large a number of feeds in the ration as possible. The principal feeds used in the Illinois experiments were corn, barley, soy beans, skim milk, and alfalfa.

[To secure uniform distribution of the nutrients of the feed] it is suggested that the grains used be ground and mixed with the milk and water, thus making a slop of all the ingredients except the mineral matter. A little of the corn, however, may be fed whole in order to develop the teeth and to accustom the pigs to feed in this form for purposes later in life when it may be advantageous to use feeds in this form.

The feeding trough should be arranged, either by a swinging panel over the trough or by having it in a separate feeding pen, so that the slop can be poured into it without being disturbed by the pigs. When the slop is in the trough and the pigs are all present the panel over the trough may be swung back or the gate, which should be a wide one, may be opened into the feeding pen so that all the pigs can come to the trough at the same time. Then, by having pigs of equal size in the lot and not having too many together, there will result a good distribution of the nutrients to the different individuals of the lot.

In the Illinois experiments alfalfa was used as a rough food primarily to furnish bulk. Pigs two months old will not eat much of it.

As they grow, however, during the next two or three months they will be able to take more, and the quantity in the ration should be increased so that the appetite of the pigs is nearly satisfied. After four or five months of age it will be necessary to gradually decrease the alfalfa in order to make room for the gradually increasing quantity of the protein and carbohydrate nutrients.

The alfalfa may be fed in the form of meal mixed with other feeds in the slop.

But this is an expensive form in which to feed alfalfa. In the summer time pigs may be allowed to eat it from the pasture. In winter the alfalfa may be chopped as fine as possible with an ordinary fodder cutter and then mixed with a little meal and sufficient hot water or steam to thoroughly wet it. This will be eaten very readily if fed while the pigs are hungry. If bran is used as a roughage it may be mixed into the slop.

It is believed that the best results will be secured by feeding three times a day except perhaps when the pigs are getting considerable green feed from pasture. In that case the noon feed may be dispensed with.

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[a] U. S. Dept. Agr., Farmers' Bul. 22.

JELLY AND JELLY MAKING.[a]

In connection with studies with fruits J. Belling, of the Florida Experiment Station, reports the results of extended investigations of the character of guava juice and of the conditions which attend successful jelly making with this fruit. According to his results, a preliminary heating of the fruit is essential, as juice expressed from the raw fruit did not flow readily, and though it gave a light, amber-colored jelly with the proper proportion of sugar, with or without citric acid, yet the characteristic guava flavor was entirely lacking. The juice from heated fruit passes through the filtering cloth more readily than that from raw fruit, and the heating also seems to help in extracting the fruit flavor.

The flavoring quality does not appear to reside in the oil glands of the rind * * *. In the boiling of guava jelly some acid (the natural acid of the ripe fruit) is absolutely necessary to change much of the sucrose into invert sugar, and if this does not take place then the sucrose [cane sugar] crystallizes out. Too much acid (and probably too prolonged boiling) seems to make the jelly sticky from the excess of invert sugar, and also to alter the pectin so that it will not gelatinize.

The pink color of guava jelly does not seem to depend on any pink color in the flesh of the fruit, though the white guavas yield a lighter jelly. The depth of color seems to be increased by additional amount of acid, prolonged boiling, and higher temperature at which the boiling is stopped.

The following directions are suggested for making guava jelly:

Cut the guavas in pieces with a sharp spoon (not iron) or with a plated knife. Heat them till quite soft in an enameled or aluminum vessel, with a small amount of water at the bottom, or in a double boiler without water. Put the soft fruit in a strong cloth bag, or folded in a cloth between boards, under a strong press. Measure the hot juice. Heat it in a deep clean pan (leaving room for the extensive frothing), adding a quantity of powdered white sugar equal in bulk to the undiluted juice. When the sugar has dissolved, the hot solution may be filtered through cloth. Boil down until the thermometer in the liquid marks the point which gives jelly of the color and consistency desired, which may be 113° C. (235° F.), or some neighboring temperature. Run the hot liquid into glass jars or into molds. Tough jelly which is not sticky may be satisfactorily packed in shallow ornamental boxes, as is done in Cuba.

Guava juice ferments quickly after it is expressed. According to Professor Belling, when it is desirable to keep the juice for jelly making—

It may be put hot from the press into clean glass bottles or jars immersed to the neck in hot water, which is then kept above 140° F. for half an hour or so. The stoppers, corks, caps, or rubber rings should be heated in the same way and the bottles of juice closed when hot. Such sterilization of the acid juice will obviate the necessity for the addition of chemical preservatives.

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[a] Compiled from Florida Sta. Rpt. 1908, pp. 105–109; U. S. Dept. Agr., Office Expt. Stas. Ann. Rpt. 1907, p. 29; Jour. Home Econ., 1 (1909), No. 3, pp. 261–266; Jour. Indus. and Engin. Chem., 1 (1909), Nos. 6, pp. 333–340; 7, p. 436.

At the department of household administration of the University of Chicago Miss Jenny H. Snow studied the effects of sugar and temperature on fruit juices. It was found that "currants, grapes, and plums would jelly without adding sugar, but the product was neither clear nor palatable and the cost, in the case of the currants, was over a dollar a glass."

Jelly which contained the smaller proportion of sugar (one-half cupful to a cupful of juice) seemed to keep as well as that containing the larger proportion (one cupful of sugar to one of juice).

In the case of apples, the average density of jelly at the boiling point was not far from 30°. With plums it was on an average somewhat lower; with currants it varied from 24 to 28°, being about 27° on an average.

The density at which a good product may be obtained varies with different fruits, but seems to be nearly uniform for each fruit and not affected by the amount of sugar used.

This density was obtained at a lower temperature and in less time with the larger amount of sugar. Tho smaller the amount of sugar used the longer the period of boiling required and the darker tho color of the product.

In each case the smaller tho amount of sugar the more pronounced the fruit flavor of the jelly.

Miss Snow also studied the effect of adding sugar to acid fruit before and after cooking. The belief is quite widespread among housekeepers that if sugar is added after fruit is cooked a smaller quantity is required for sweetening than is the case when it is added before cooking. Miss Snow also studied the relative sweetness of cane sugar (the ordinary sugar which is obtained from sugar cane, sugar beets, and the sugar maple) and invert sugar (dextrose and levulose), which are found in nature in fruits, etc., and which can be obtained from cane sugar by inversion, as, for instance, by cooking sugar with acid. According to her results, dextrose is much less sweet and levulose sweeter than cane sugar, while a mixture of equal parts of dextrose and levulose is sweeter than cane sugar.

When cane sugar was added to apples before cooking and boiled with them, it was found to be largely inverted. When added at the close of the cooking period, it was only slightly inverted, and, although the invert sugar is less sweet than cane sugar, yet "the difference in sweetness between stewed apples when the sugar has been added before and after cooking, respectively, is so slight as to be of little practical consequence * * *.

"The experiments, with one exception, show that the acidity is less in apples cooked in water, either with or without sugar, than in uncooked fruit."

An extended study of the chemistry and physics of jelly making, carried on by Miss N. E. Goldthwaite at the department of house-

hold science, University of Illinois, gave a number of results which are of general interest.

Miss Goldthwaite states that—

The essential constituents of a jelly-making fruit juice are: First, pectin [a carbohydrate body closely related to starch and a very common constituent of fruit and some vegetables]; second, acid. A desirable accessory constituent is cane sugar. Too much sugar is likely to be used in jelly making, with a consequent deterioration of the quality of the jelly. The amount of inversion preferably produced in this cane sugar is yet undetermined.

Overdilution of fruit juice [with water] should be avoided, since this leads to the use of too much sugar; probably the extra boiling thus rendered necessary also impairs the texture of the jelly.

The physical constants of hot juice ready to jelly on cooling are, substantially, boiling point, 103° C., and specific gravity, 1.28.

Jelly is readily made through boiling pectin with acid, water, and sugar.

Jelly making seems to consist in so controlling conditions by means of acid and sugar and boiling as to cause the pectin to be precipitated in a continuous mass throughout the volume allotted to it.

The fall fruits used in these jelly-making studies were covered with cold water, brought to the boiling point, and thoroughly cooked, and the juice allowed to drip through a filter made of a double fold of cheese cloth.

It was found that the pulp remaining on the filter could be again boiled up with water (the least amount possible) and that the resulting juice would make a good jelly. This was particularly true in the case of grapes, even the fourth and fifth extractions making an excellent quality of jelly—a quality better than that made from the first extraction because potassium acid tartrate crystals did not appear in it, as is usual in the case of jelly from grapes.

As previously stated, the presence of acid is considered essential for jelly making and a number of tests were carried on in which citric acid and tartaric acid, i. e., organic acids which occur normally in fruit juices, were used in different proportions.

From the results it appears then that—

Through this addition of an organic acid to a fruit juice containing naturally little acid, jellies can be made if these juices contain pectin. However, the flavor of the fruit is generally changed; the sweet-apple jelly so made tasted much like that made from sour apples, the tartness of course increasing with increasing percentages of acid; the flavor of the pears, in pear jelly, was fairly well preserved, while in peach jelly the peach flavor was completely destroyed. Repeated experiments, varying the percentages of acid, were made in an endeavor to preserve the peach flavor, but success was not attained in this respect, though a jelly of fair texture could be produced. From experiments testing the relative merits of tartaric and citric acids in connection with the use of one or the other to acidify a fruit juice, the balance of favor seemed to be with the former. Both texture and flavor of jellies made by its use were superior to those in which citric acid was used.

These experiments are of special interest in view of the general household practice of adding sour fruit like currants or crab apples to sweet fruits like raspberries or elderberries to make a jelly of

good consistency, and the even more common addition of lemon juice to jams and jellies made from a great variety of fruits. When currants or sour apples are thus used, pectin as well as acid is added, while with lemon the improvement in flavor is perhaps the consideration most often in mind, though many housekeepers realize that the lemon juice will make the material "jelly."

According to Miss Goldthwaite—

That so-called jellies can be produced by merely boiling down fruit juices is well known. Naturally the flavor of such a jolly is decidedly fruity, but in texture it is very tough. The making of such jellies requires a largo amount of juice, e. g., we found to make one glass of such apple jelly required a volume of juice sufficient for six glasses when made with sugar. Ordinarily, sugar is cheaper than fruit juice, so from the standpoint both of palatability and of economy (possibly also of digestibility) jellies made with sugar aro preferable. * * * It seems better not to boil sugar and juice together from start to finish in jelly making, but rather to add the sugar so that it may be boiled with the juice for a period not to exceed one-half the total time of cooking.

Apparently the texture of the jelly may be greatly impaired by excessive cooking of an overdiluted juice.

The investigations summarized above not only furnish the housekeeper with information which is of use in jelly making, but also provide the teacher and student with additional data which is of value in understanding the physical and chemical problems which underlie this household process.

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